characters in various combinations but were considered to be *T. sulcifrons.*

It is interesting to note that no specimens of subspecies *pallidescens* Philip were present in the 187 specimens of *T. fulvulus* examined although this form has been collected in Tennessee. There were no intergrades between the 27 specimens of *T. molestus* and 149 of subspecies *mixis.* The series of *T. molestus mixis* showed considerable variation in width and shape of frons and in the shape of the basal portion of the third antennal segment.

The cooperation of Prof. Dietrich and Mr. Benesh in making this interesting collection available is appreciated. I am indebted to Mr. William Wild of the Buffalo Museum of Science for the preparation of the accompanying distribution chart.

A STUDY OF THE BIOLOGY OF PRIOCNEMIS MINORATA BANKS (HYMENOPTERA, POMPILIDAE).

By Carl M. Yoshimoto,[1] Ithaca, New York.

In the spring of 1953, I had an opportunity to make several observations on the nesting habits of *Priocnemis* (*Priocnemis*) *minorata* Banks near Ithaca, N.Y. Most of my studies were made at Bull Pasture Pond, about two miles northeast of the Cornell University campus. The environment is a typical open oak-maple woodland with a pond nearby; part of the land has been cleared for a golf course. The ground is thickly covered with dry leaves and twigs where *P. minorata* nested. Two observations were made at McLean Wildlife Reservation, about 14 miles east of Ithaca, in a wooded area.

There have been no previous publications on the habits of this species, or any other member of this subgenus, in North America. My sincere thanks go to Dr. H. E. Evans for identification of the pompilid and some additional notes on its biology. I also wish to express my thanks to Dr. Willis J. Gertsch of the American Museum of Natural History for the identifications of the spiders.

The ten separate observations bear note numbers 401 through 410. Reference is made to these numbers in the text; the field notes and associated specimens are on file at Cornell University.

[1] Cornell University.

Usually the writer spent at least six hours per day in the field to record the nesting activity of only one individual. Occasionally two or three individuals were observed nesting on warm sunny days (approximately 78° F.). After a few observations, the height of the nesting activity was correlated with the temperature and the time of day. On a sunny day (70°–80° F.), the peaks of activity were from 9:30 a.m. to 11:00 a.m. and from 3:30 p.m. to 6:00 p.m. On cool and cloudy days, there was very little activity, and on rainy days *minorata* would seek shelter in her nest or under the dried leaves on the ground.

P. minorata appears at Ithaca early in the spring, and for some weeks is the only species of pompilid present. Males have been collected at Ithaca from April 13 through May 11. The females appear approximately a week later than the males. Dates of females collected at Ithaca range from April 21 to June 14. During the span of the adult life, both males and females occasionally visit flowers for nectar; specimens have been taken by H. E. Evans on choke cherry, *Prunus virginiana* L., and on the catkins of willows, *Salix sp.*

Hunting

Many females were observed hunting their prey during the course of these studies. The wasp flickers her wings constantly when hunting for prey; this is characteristic of most members of this family. The antennae vibrate close to the ground as the wasp searches above and under fallen leaves and ground litter. Occasionally, short (.5–1 meter) and long (3–5 meters) flights are made to seek for better hunting ground. In none of my observations did I detect the manner in which the female wasp captures her prey.

Fifteen spiders were taken from wasps or from the cells and submitted for identification; nine others were used for rearing larvae. These specimens represent six species belonging to four families: Agelenidae, Anyphaenidae, Clubionidae, and Lycosidae (see table 1). All of the spiders were adult females except for the two indicated.

In order to study the variation in weight of the spiders taken, I selected two paralyzed spiders of extreme size and weighed them. The largest spider (no. 404, cell 4, *Wadotes hybridus* Emerton, female) weighed 404 mg. and the smallest (no. 404, cell 5, *Wadotes hybridus* Emerton, female) weighed 55 mg.

Table 1

List of spiders taken as prey by *Priocnemis minorata* Banks

Agelenidae

Coras juvenilis Keyserling, imm. female
Wadotes calcaratus Keyserling, female
Wadotes hybridus Emerton, female

Anyphaenidae

Aysha gracilis Hentz, female

Clubionidae

Clubiona obesa Hentz, female

Lycosidae

Trochosa pratensis Emerton, female

Transportation

The first nesting activity of *P. minorata* was observed on May 9, 1953, when I accidentally came across a female *minorata* with her spider (no. 401). In this and later examples observed, the wasp always transported her prey by walking backward, grasping the spider in her mandibles by the hind coxae in an upright position. The body of the spider is thus perpendicular to the wasp's body, forming a "T." In many cases, the prey outweighs the wasp many times, and the wasp drags the prey instead of holding it in mid-air. In several cases, the wasp traveled a considerable distance to her nest (6 to 10 meters). In a few exceptional cases, the female wasp traveled over ten meters with her prey. During the journey to the nest, the wasp may pause several times, the number of times being more or less proportional to the distance from the place of capture to the nest. During her brief stops, she either holds the prey with her mandibles and remains motionless, or deposits the spider and cleans her antennae and mouth parts with her fore legs. One wasp (no. 401) made an attempt to climb backward on a stiff grade (60° angle) of an old dry leaf with a large prey. She took several minutes struggling to get on the other side of the leaf. In another case (no. 403), a wasp walked backward up a young tree (one meter) but did not fly with her large prey. After reaching the top of the plant, she walked forward toward the ground and continued her journey.

During the process of transporting the prey, one female wasp (no. 402) met another female wasp. The intruder tried to steal

the prey away by pulling one of the spider's legs. The defender abandoned her grip on the spider and jumped on the intruder's back. A moment later, both tumbled over and over on the ground. Then a few seconds later after the violent struggle, the defender regained control of the prey and chased the intruder away with her wings vibrating in a diagonal position.

The female *minorata* has an excellent memory for the location of her nest. In no case observed was an individual seen to deposit her prey to make exploratory trips forward in the direction of the nest, as is so often done by the related species, *Priocnemis* (*Myrmecosalius*) *cornica* (Say). No matter what the distance might be, *minorata* always proceeded directly to the nest in almost a straight line. This seems all the more remarkable when it is recalled that the wasp is walking backward over a rough bed of leaves and sticks.

Nesting Activities

The manner in which minorata constructs the nest was never observed, the reason being that the species digs the nest beneath dried fallen leaves and nothing can be seen from above. The first nests were discovered by watching several individuals (nos. 401, 403, 404) with their prey. After placing the prey on the top of a leaf, each of these wasps entered the pile of leaves and came out a minute later and grasped the spider's third coxa and walked between the leaves and disappeared below. The leaves were removed immediately from the area. In each case the female wasp entered the burrow to make an inspection trip, leaving the spider near the entrance. After the inspection trip, the wasp came halfway out the entrance and grasped the spider by its spinnerets and dragged it backward into the burrow. Female wasps which got their prey during the later afternoon usually confined themselves in the nest the rest of the day. After some experience, nests could easily be spotted under the dried leaves. The nest entrance is left opened during the entire duration of nesting. The entrance is a hole about .7 cm. in diameter surrounded by rim of ferruginous and cream-colored clay-loam soil which is dug from the burrow, giving somewhat the appearance of an ant hill.

On May 10, at Bull Pasture Pond, I saw a *minorata* carrying a spider (no. 404) to her nest in the same manner as mentioned above. She left the prey next to the entrance and entered the burrow. I took the prey and kept it as a prey record. Several hours later, I dug out the nest and found seven cells (fig. B). I started

to dig 15 cm. away from the hole to a depth of 30 cm. below the ground level and gradually worked inward and followed toward the top. There were hardly any pebbles or roots in the nest area. I located the cells in ascending order. A medium size larva feeding on a *Wadotes hybridus* was found in the first cell, perpendicular to the earth surface and at a depth of 25 cm. The second cell was 2.5 cm. to the left and slightly above the first cell; this contained a slightly smaller larva feeding on another spider, *Aysha gracilis.* As I dug 1.5 cm. higher and considerably to the right, the third cell was discovered; in this cell there was a very small larvae feeding on a *W. hybridus.* The fourth cell was found on the opposite side, 2.5 cm. above the second cell; this contained another *W. hybridus* with an egg laid on its abdomen. The fifth cell was dis-

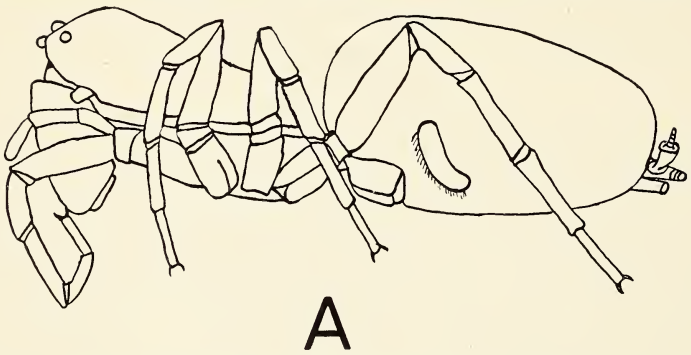

Fig. A—A typical position of the egg on the abdomen of *Wadotes hybridus* Emerton, female (no. 404, cell 1).

covered above the third cell; this cell contained a medium *W. hybridus* with an egg on its abdomen. The sixth cell was located 4 cm. above the fourth cell and 4 cm. from the end of the open part of the burrow; this contained a small yellow-reddish spider, probably *Trochosa pratensis,* with an egg on its abdomen. The topmost cell with a fresh egg laid on the spider's abdomen was found 2.5 cm. above the fifth cell and 4 cm. away from apex of the burrow. The open burrow led diagonally 7.5 cm. to the surface. Below this depth the main burrow and side burrows were filled, although they could be partially traced by the somewhat loose soil in the burrow. All of the spiders were placed in the salve cans to be reared.

On May 16th (no. 405), at McLean I found a nest at the foot of a hill near Mud Pond. Although there appeared to be only one cell, digging the nest out was very tedious. There were at least

three roots, 2.5 cm. in diameter and several stones and pebbles adhering tightly to the clay soil. The open burrow went 5 cm. deep into the ground; then it curved, twisted between roots and stones to a depth of 20 cm. The cell contained a spider with an egg on its abdomen found 2.5 cm. away from the end of burrow. At the same locality on June 2nd, another nest was discovered (no. 407) at the

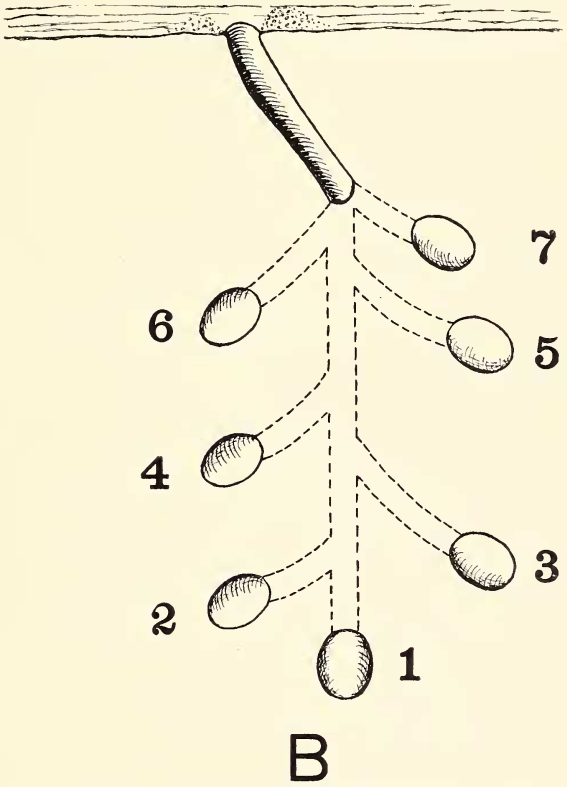

Fig. B—Nest (no. 404) of *Priocnemis minorata* with seven cells.

summit of a rolling hill near Mud Pond. The burrow extended diagonally 6.5 cm. to a blind end with hardly any roots or pebbles. Below this were found six cells, closely arranged more or less spirally in ascending order, suggesting a bunch of grapes hanging from a stem. I found four cocoons, one to each cell in the first four cells from the bottom. In the fifth cell there was a small larva feeding on the spider's abdomen; and in the topmost cell, the sixth,

a spider with an egg on its abdomen. Both spiders were *Wadotes hybridus*.

Five additional nests were dug out at Bull Pasture Pond. Number 406 contained a single cell at a depth of 12.5 cm. Number 403 was open down to a depth of 19 cm.; two cells were found, one at a depth of 22.5 cm. and another at a depth of 27.5 cm. The former contained a spider which for some reason had no egg on it; the latter contained a small larva. Nest no. 409 contained two cells; number 408 contained four cells and no. 410 contained five cells. In general, the arrangement was similar to that described and figured for nest no. 404, except for modification to avoid roots and stones.

The eight nests dug out varied in depth from 12.5 to 27.5 cm., measured from the surface to the deepest cell. The cells were ordinarily spaced from 2.5 to 4 cm. above one another in various directions off the main burrow. This is suggestive of a vegetative twig of a woody plant with alternate leaves placed upside down; the leaf blades could be imagined as the number of cells. The cells are nearly uniformly $2 \times 1.5 \times 1$ cm. in size. Each time the female wasp completes a cell, she plugs with earth the burrow extending from the main shaft to the base of the cell, this burrow being usually about 2.5 cm. in length.

If the female wasp was fortunate enough to select a nesting spot with few roots and stones beneath the ground, the number of cells found per nest was probably more or less directly related to the time required to construct a cell. In cases where many obstacles were in the way of nesting, the burrow was constructed so as to avoid stones and roots (nos. 403, 405, 406, 409); these examples generally had a smaller number of cells, ranging from one to two per nest. In cases where there were less roots and stones in the ground, the maximum for one nest was five to seven cells. The top three inches of soil was dark loam interlaced with roots, root hairs, and pebbles. Beneath the first layer of soil, the rest was largely pale clay-loam soil and large rocks. Occasionally roots of 3 to 8 cm. diameter were present. Whether a female utilizes one nest for the entire season or whether she constructs additional nests is unknown.

Immature Stages

The spider is almost always placed on its right side in the cell with the egg on top, attached latero-ventrally close to the base of the abdomen. The egg is about 1 mm. in diameter and 3 mm. long;

it is opal white and slightly curved in the middle (fig. A). The eggs on the spider prey were reared in salve cans in the laboratory where the average room temperature was 75° F. In about forty-eight hours, under these conditions, the egg hatches into a tiny larva. The young larva feeds on the body fluid of the spider in the same position as the egg was laid for three or four days, and by then has consumed the spider's abdomen. By this time, the mandibles are apparently strong enough to consume the body of the spider, and the larva feeds upon the cephalothorax. At room temperature a total of five to six days are required for the larva to devour the entire spider. After finishing the spider, the larva starts to spin its cocoon. The silk is first attached from wall to wall of the cell, then is gradually spun into an oval cocoon occupying the center of the cell and enclosing the larva. Under the much cooler temperature of the nest in the soil, development is undoubtedly much slower. From a total of fifteen attempted rearings, only six of the eggs were reared through the larval stage. The other nine were attacked by mold and nematodes on the egg as well as on the young larvae. Four last instar larvae were placed in preservative fluid to be described later. Several spiders on which the egg or larva had died were kept to find the duration of paralysis of the spider. The spiders survived without food for 17 days (smaller species) to 33 days (larger species) before dying. They showed no signs of recovery from paralysis.

The cocoon is a brown, oblong ovate pouch, held by many fine silk threads to the walls of the cell. Four cocoons have been kept from June, 1953 until Dec., 1953, and as yet no adults have emerged. There is no evidence that this species has more than one generation a year.

Discussion

In a number of ways, *Priocnemis* (*Priocnemis*) *minorata* is rather strikingly different from most other native Pompilidae. It is an early spring species and occurring in woodlands and nesting in heavy clay-loam soil often containing many roots and stones. The nests are constructed beneath fallen leaves and are very difficult to detect unless one follows the female wasp with her prey to the nest. The female wasp always proceeds backward in a straight line to her nest with the spider, without making exploratory trips like *P. cornica*.

The nests were always found to be open and contained from one to seven cells. The preparation of several cells per nest is a most

unusual trait for a Pompilidae. It has never been described for a North American species; however, the present writer, H. E. Evans, and C. S. Lin have found that, in two widely separated localities, *Priocnemis* (*Myrmecosalius*) *cornica* (Say) prepares up to seven cells to a nest (unpublished observations). However, *P. cornica* utilizes mostly ready-made holes such as abandoned tiger beetle holes. Adlerz (1903, 1912) in Sweden found *Priocnemis exaltatus* (Fab.) closing a lateral cell of the gallery of the nest. While digging out the nest, he also found nearby two other enclosed cells previously stored with prey. In France, Soyer (1939) made many observations on *Priocnemis propinquus* (Lep.) which utilizes other animal burrows and constructs several lateral cells. The burrow is left open during each nesting. In Chile, Claude-Joseph (1930) also made some observations on four species of the genus *Salius* (= *Priocnemioides*). One of these, *Salius flavipes* Guer. nests in abandoned lizard, grasshopper, and cricket burrows; several lateral cells are constructed with the entrance kept opened between nesting. *S. dumosus* Guer., *S. hirticeps* Guer. and *S. dispertitus* Kohl similarly construct several cells to a nest. Therefore it appears that the habit of preparing several cells for a single gallery occurs in several species of *Priocnemis* and also in certain related genera.

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CONCERNING TYPE LOCALITY AND TYPE FIXATION OF THE NORTH AMERICAN ANT, MYRMICA EMERYANA FOREL.

By Marion R. Smith,[1] Washington, D.C.

This ant was originally described by Forel as *Myrmica scabri-*

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